

PCBs in Caulk and Paint

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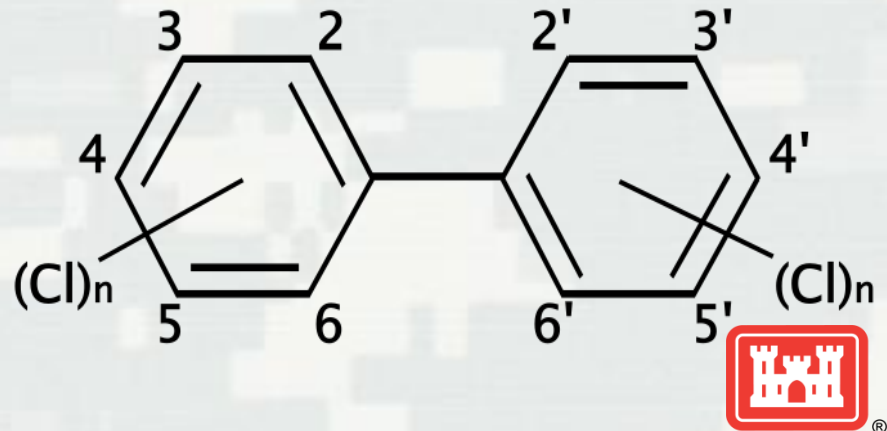
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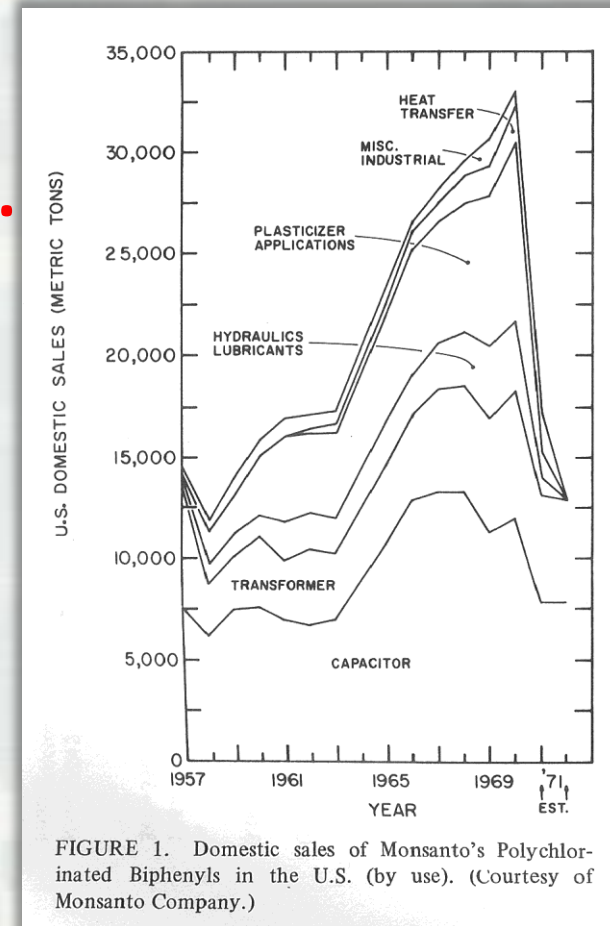
Polychlorinated Biphenyls

- Polychlorinated Biphenyls – PCBs
- Organic Compound
- Different congeners – *different properties*
- Marketed under the trade name **Aroclor**
- Aroclor 1260
 - ▶ 12 carbon atoms
 - ▶ 60% chlorine by mass.



PCBs Manufacture

- First PCBs were synthesized in **1881**.
- Manufactured by:
 - ▶ *Anniston Ordnance Company*
1927
 - ▶ *Swann Chemical Company*
1930
 - ▶ *Monsanto Industrial Chemical*
1935-1977
- Sauget, Illinois and Anniston, Alabama
- Production peak - **1970**



The chemistry of PCB's, 1974



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PCB Ban

- Federal law banned U.S. production of PCBs
 - ▶ July 2, 1979
- Toxic Substances Control Act (TSCA)
 - ▶ Bans the manufacture, processing, use and distribution in commerce of PCBs
 - ▶ Gives EPA authority:
 - *To develop, implement and enforce regulations for the use, manufacture, cleanup and disposal of PCBs*
- Current PCB regulations
 - Code of Federal Regulations (CFR) at 40 CFR 761



Potential PCB sources

- Any of these products if manufactured before 1979:
 - ▶ Capacitors or transformers
 - ▶ Mineral-oil filled electrical equipment
 - ▶ Fluorescent light ballasts
 - ▶ Waste or debris from the demolition of buildings and equipment manufactured, serviced, or coated with PCBs
 - ▶ Waste containing PCBs from spills, such as floors or walls contaminated by a leaking transformer



Potential PCB sources

- ▶ Plastics
- ▶ Molded rubber parts
- ▶ Applied dried paints
- ▶ Oil-based paints
- ▶ Coatings/Sealants
- ▶ Caulking
- ▶ Adhesives and tapes
- ▶ Carbonless copy paper
- ▶ Galbestos
- ▶ Sound-deadening materials
- ▶ Insulation



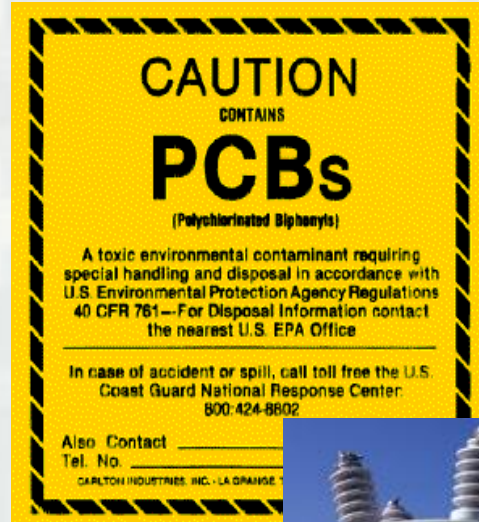
PCBs in Transformers

- **Transformers** are devices that can increase or decrease the voltage level of an electrical current.
 - ▶ filled with dielectric fluid, *PCB-based oil mixtures*
 - ▶ Manufactured between 1929 and 1977
- Trade names for PCBs in transformers
 - ▶ Abestol, Aroclor, Askarel, Chlophen
 - ▶ Chlorextol, DK, EEC-18, Fenclor
 - ▶ Inerteen, Kennechlor, No-Flamol, Phenoclor
 - ▶ Pyralene, Pyranol, Saf-T-Kuhl, Solvol
 - ▶ Non-Flammable Liquid



PCBs in Transformers

- 40 CFR 761
- **PCB Transformer**
 - ▶ PCBs at concentrations **≥ 500 ppm**
 - ▶ Requirements for management:
 - PCB Transformers must be registered
 - Visual inspections
 - Proper PCB identification labels
 - Records of inspections and maintenance
 - ▶ PCB transformers may be disposed:
 - TSCA chemical waste landfill



PCBs in Caulk

- **Caulk** is a flexible material used to seal gaps to make windows, door frames, masonry and joints in buildings and other structures watertight or airtight.
 - ▶ PCBs imparted flexibility
 - ▶ Used in many buildings, including schools, in the 1950s through the 1970s
- September 2009, EPA provided new guidance to communities



PCBs in Caulk

- Exposure may occur by:
 - ▶ Release from the caulk into the air
 - ▶ Dust
 - ▶ Surrounding surfaces and soil
 - ▶ Direct contact.
- The link between the concentrations of PCBs in caulk and PCBs in the air or dust is not well understood.



<http://www.epa.gov/pcbsincaulk/caulkexposure.htm>



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PCBs in Caulk - Recent Studies

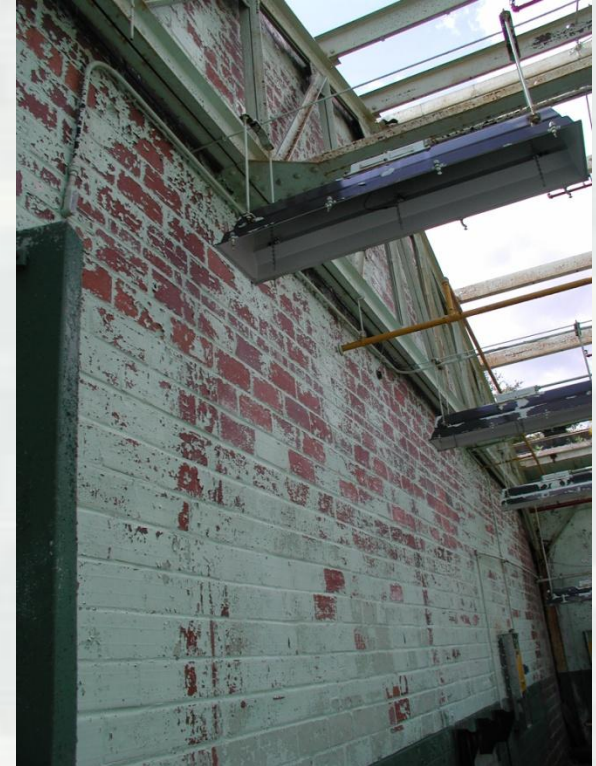
■ New York City Schools

- ▶ Agreement with EPA to address PCBs in caulk
- ▶ The city will conduct a study in five schools
- ▶ Assess and reduce potential exposure
 - Cleaning schools
 - Improving ventilation
 - Addressing deteriorating caulk
- ▶ City will ensure any PCB waste is removed
- ▶ After finalizing the study a plan will be developed and implemented - *identify, prioritize, and address*



PCBs in Paint

- PCBs were used in paints
 - ▶ To enhance structural integrity
 - ▶ Reduce flammability
 - ▶ Increase antifungal properties
- PCBs imparted heat resistance to the paints
- EPA reports PCBs concentrations in dried paint at a range from 1 ppm to 97,000 ppm



PCBs in Paint

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THE CHEMICAL FORMULARY

Swimming Pool Paint

Lacquer Phase:	For Concrete		For Steel
	Formula No. 1	No. 2 ^a	No. 3 ^b
"Parlon" (20-cp)	100.0	100.0	100.0
"Duraplex" C-49 (100%) ^c	50.0	50.0	50.0
"Aroclor" 1254	50.0	50.0	50.0
Titanium Dioxide			
(Rutile)	112.0	112.0	50.5
Magnesium Silicate	115.0	116.0	50.7
Phthalocyanine Green	2.9	3.0	1.3
"Bentone" 34	13.0	12.0	5.0
"Tween" 60	—	8.5	—
Epichlorohydrin	1.0	—	0.6
Xylene	450.0	210.0	285.0
"Solvesso" 100	90.0	50.7	28.0

Water Phase:

Methylcellulose (4000 cp)	—	7.6	—
Sodium Oleate	—	15.7	—
Distilled Water	—	520.0 ^d	—

Properties:

Solids, wt %	45.1	64.1	50.0
Pigment vol-con, %	35.0	35.0 ^d	20.0
Viscosity, Krebs units	74.0	—	75.0
Viscosity, Brookfield, cp			
No. 4 spindle, 30 rpm	—	6,000	—
No. 4 spindle, 12 rpm	—	12,000	—

^a Emulsion, prepared by slow addition of water phase to lacquer phase with mixing until smooth emulsion is formed

^b Meets gloss requirements of Federal Specification TT-P-95

^c Made compatible by the presence of "Aroclor" 1254

^d In lacquer phase

Masonry Paints

For Swimming Pools	For Bricks, Asbestos Shingles, and Similar Surfaces		For Porous Masonry	
	No. 1	No. 2	No. 3	No. 4
"Parlon" S10	—	—	5.30	—
"Parlon" S20	8.00	11.50	—	8.60
"Duraplex" C-49	4.00	—	—	—
"Clorafin" 40	—	4.35	1.95	—
"Aroclor" 1254	4.00	—	—	—
"Duraplex" D-65A (85%)	—	7.11	3.27	—
Raw linseed oil	—	—	—	6.40
Linseed oil, heat-bodied, viscosity Z3	—	—	—	6.40
Titanium dioxide	15.20	10.30	20.60	11.40
Zinc oxide	—	3.90	4.10	4.30
"Asbestine" 3X	15.20	6.40	10.40	7.20
Mica (325 mesh white waterground)	—	5.10	6.30	5.80
"Bentone" 34	1.60	—	2.50	2.90
"Amsco Solv" D	—	33.74	31.46	31.16
"Solvesso" 100	—	13.40	10.60	12.00
Turpentine	—	3.54	3.20	3.30
Xylene	51.96	—	—	—
Epichlorohydrin	0.04	0.06	0.03	0.04
"ERL" 2774	—	0.60	—	0.40
Cobalt naphthenate, 6%	—	—	0.03	0.10
"Dyphos"	—	—	0.26	—

Aroclor 1254 most commonly used for paints

The Chemical Formulary – VOL XV, 1970



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PCBs in Paint



PCB containing paint at closed Army ammunition plants has compromised and delayed the decontamination processes.



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Field Detection Technologies

- Enzyme-linked immunosorbent assay (ELISA)
 - ▶ Antibodies bind with a selected environmental contaminant
- Antibody-antigen reaction
 - ▶ PCB-specific antibodies
 - ▶ Colorimetric Reaction
 - Amount of color inversely proportional to concentration



RaPID Assay PCB Test Kit



PCB in soil Pocket Colorimeter Test



PCB Rapid Strip Test Kit



Field Detection Technologies

■ L2000 PCB/Chloride Analyzer

- ▶ Principle of total organic chlorine detection
- ▶ Electrochemical analysis using an ion-specific electrode
- ▶ Wipe sampling kit



Recommended use: Aroclor known – no halogenated organics



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Bimetallic Treatment System (BTS)

- Removes and degrades PCBs from structures and coatings such as paint and adhesives utilizing an in situ approach
- Two step process:
 - ▶ Extract PCBs without destroying the paint
 - ▶ Partition the PCBs into an environmentally friendly solvent



Bimetallic Treatment System (BTS)

- Applied to paint by wipe or spray
- Solvent Solution with catalyzed zero-valent metal
 - ▶ Ethanol and limonene
 - ▶ Mg/Pd bimetallic
- Mixture forms a paste - spray sealed
- Removes PCBs from paint
 - ▶ 80% within 4 hours
 - ▶ 100% within 48 hours



<http://nasaksc.rti.org/Bimetallic.cfm?pageID=BimetallicTechnology>

The technology has been field demonstrated at Cape Canaveral Air Station, FL and Badger Army Ammunition Plant, WI.



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Recent Studies

■ PCB blood levels in teachers

- ▶ Germany
- ▶ 151 teachers from 5 different schools
- ▶ Study found moderate elevations of blood levels of PCB-28 and PCB-101 among teachers in some schools

Abrasion-Resistant Floor Finish

<i>Solids</i>	
"Parlon" S20	50
"Aroclor" 1254	25
"Duraplex" C-55	25
<i>Solvents</i>	
"Solvesso" 100	80
Xylene	10

The Chemical Formulary – VOL XV, 1970

■ PCBs in wood floor finish

- ▶ Cape Cod, MA
- ▶ Detected PCBs in indoor air in 31% of 120 homes
- ▶ Study found elevated blood PCB concentrations in residents of homes.

Gabrio T. et al., PCB-blood levels in teachers, working in PCB-contaminated Schools, Chemosphere 40(2000)1055-1062

Rudel R. et al, PCB-containing wood floor finish is a likely source of elevated PCBs in residents' blood, household air and dust: a case study of exposure, Environmental Health 2008, 7:2



New Concerns

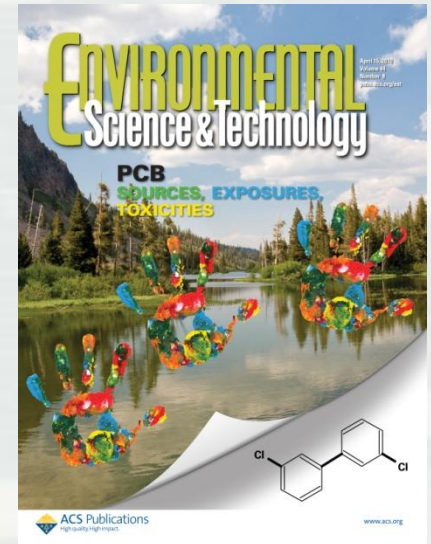
■ PCB 11 – 3,3'-dicholorbiphenyl

- ▶ Byproduct of manufacturing process
- ▶ Linked to the manufacture of organic yellow coloring – *diarylide pigment*
- ▶ Suspected to be released when paint vaporizes
- ▶ Has been discovered in consumer products
 - Printed newspaper
 - Yellow cereal boxes
 - Plastic bags
- ▶ Present in air samples - Chicago, Philadelphia, the Arctic
- ▶ Studies – *University of Iowa and Rutgers University (ES&T)*



What's Next?

- EPA is proposing changes to PCB regulations to address issues like PCBs in caulk
- New procedures should be implemented
- ES&T journal issue dedicated to PCBs
 - ▶ April 15 2010
 - ▶ Volume 44, Issue 8, pages 2747-3200
- Public Works Technical Bulletin (PWTB)



Questions?

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